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Immunization derived from a polynomial duration vector in the Spanish bond market

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Abstract

This paper focuses on the Spanish government debt market in an attempt to evaluate the immunization performance of the polynomial duration model of Chambers and Carleton (Chambers, D.R., Carleton, W.T., 1988. A generalized approach to duration. In: Chen, A.H. (Ed.), Research in Finance, vol. 7, JAI Press, Greenwich, pp. 163–181), in default-free and option-free fixed-income portfolios and to ascertain whether traditional convexity is an earnings-generating element. Empirical tests show that three constraints, namely those related to the level, slope and curvature of term structure shifts, are necessary to guarantee a return close to the target. The only exception to this rule is found in portfolios including an asset that matures near the horizon date, in which classical immunization performs properly. © 2001 Elsevier Science B.V. All rights reserved.

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1. Introduction

Duration and convexity are well-known concepts in the area of interest risk management. However, the simplicity that characterizes both concepts is based on an extreme simplification of interest rate movements, which are defined as parallel and instantaneous shifts in the term structure of interest rates.

This unreliable assumption has motivated the development of alternative formulations that try to capture more effectively the real risk of fixed-income portfolios during the last 25 years. More particularly, recent years have seen many refinements of duration models towards what we may call *empirical multiple factor duration models*, that is, models involving several duration measures that look for reality-based relations between interest rate changes, with no reference to theoretical arguments about the stochastic dynamic of markets. Such empirical multiple factor duration models could be categorized into *directional duration models*, *partial duration models* and *polynomial duration models*.

The first group, directional duration models, attempts to use movements in the term structure of interest rates to deduce the state variables, observable or not, which govern changes of the whole curve. This type of model is found, among others, in Elton et al. (1990); Litterman and Scheinkman (1991); Navarro and Nave (1997) and Barber and Copper (1996).

Partial duration models explain interest rate changes by shifts in the level of the different segments into which the term structure is subdivided or by shifts in a limited number of interest rates. Specifically, we refer to the models of Ho (1992), Reitano (1990,1992,1993,1996) and Johnson and Meyer (1989).

Finally, polynomial duration models have their origin in the works of Chambers and Carleton (1988) and Prisman and Shores (1988), who assume a polynomial fitting of term structure shifts. A more generalized approach is suggested by Nawalkha and Chambers (1997), who derive a polynomial bond return generating function without requiring that term structure shifts be expressed as a polynomial. [1]

Without any doubt, the least restrictive model is the polynomial duration model, since it does not require, as the others do, the relation between interest rates to be constant or the segmentation of the term structure into an arbitrary number of segments or vertices. The only prerequisite of this model is that the bond return generating function must be expressed as a polynomial.

[1] Clearly, if term structure shifts are expressed as a polynomial, the bond return generating function will also be a polynomial. The reverse is not necessarily true.